A Preliminary Analysis of Self-incompatibility in Sour Cherry

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Additional index words. *Prunus cerasus*, pollination

Abstract. Self-incompatibility was investigated in sour cherry (*Prunus cerasus* L.) by examining pollen growth in the pistil by use of ultraviolet fluorescence microscopy following self- and cross-pollination. The sour cherry cultivars Tschernokorka and Crisana exhibit pollen tube inhibition in the style characteristic of gametophytic self-incompatibility. 'Meteor' and 'Montmorency' appear to be partially self-incompatible, with few self-pollen tubes reaching the ovary. Several hybrid seedlings from crosses between self-compatible cultivars were self-incompatible, suggesting that these self-compatible parental cultivars carry self-incompatibility alleles.

Self-incompatibility in *Prunus* is widespread. Most commercial almond (*P. dulcis*) (Crossa-Raynaud and Grasselly, 1985; Socias i Company et al., 1976) and sweet cherry cultivars (*P. avium* L.) (Crane and Brown, 1937; Crone and Lawrence, 1929; Way, 1967) exhibit gametophytic self-incompatibility and cross-incompatible groups have been identified. In plums (*P. domestica*), the expression of self-incompatibility is more complex. Plums can be self-compatible, self-incompatible, or partially self-compatible, with only a few examples of cross-incompatibility reported (Crane and Lawrence, 1929; Suranyi, 1978).

Although the tetraploid sour cherry is generally considered self-compatible, self-incompatible sour cherry cultivars do exist (Lech and Tylus, 1983; Redalen, 1984a, 1984 b). These self-incompatible cultivars generally represent old landrace cultivars that are being replaced in commercial production by self-compatible types. Besides the two classifications of self-compatible and self-incompatible, Redalen (1984b) describes a partially self-incompatible class in sour cherry that he defined by 1.5% to 15% fruit set.

The sour cherry industry in the United States is a monoculture of the cultivar Mont-

morency. Beginning in 1983, sour cherry germplasm was imported into the United States from Europe for use in sour cherry breeding; some of the germplasm being from self-incompatible cultivars. The objectives of this study were to characterize self-incompatibility in sour cherry and evaluate seedlings from the sour cherry breeding program for self-compatibility by examining pollen tube growth in the pistil using ultraviolet (UV) fluorescence microscopy.

Plant material. A diallel cross was made among the sour cherry cultivars Tschernokorka, Crisana, Meteor, and Montmorency. 'Tschernokorka' and 'Crisana' have previously been reported to be self-incompatible (Redalen, 1984a, 1984b). Two sweet cherry cultivars, 'Emperor Francis' and 'Schmidt', were also included for comparison.

Thirty-three sour cherry progeny chosen at random from crosses involving the following parents were also evaluated: 'English Morello', 'Meteor', 'Rheinische Schattensmorelle', 'Crisana', 'Hungarian Meteor', 'Erdi Botermo', and M71. Pollen of 'Crisana' was collected in Romania (courtesy of the Research Inst. for Pomology, Pitesti), and pollen from the last three selections listed was collected in Hungary (courtesy of the Enterprise for Extension in Fruit Growing and Ornamental, Budapest). All the plant material tested is planted at the Clarksville Horticultural Experimental Station, Clarksville, Mich.

Pollination and evaluation. Pollen was collected from cut branches forced indoors at room temperature. Pollen viability was tested by the method of Werner and Chang (1981) using 3(4-5-dimethylthiazolyl-2)2,5-diphenyl tetrazolium bromide as the pollen staining agent. Flowers on branches in the field selected for crossing were emasculated at the balloon stage, all other flowers being

Received for publication 26 Feb. 1990. We acknowledge the Michigan Agricultural Experiment Station for their support of this research. We thank Steve Krebs, Colleen Mulnix, and Tom Brettin for their help on the project. This research was supported in part by the U.S. Agency for International Development (US-AID) Agronomic Institute Project no. 608-0160. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

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Fig. 1. Pollen tube growth in sour cherry pistils: (left) 'Crisana' self-pollinated, (center) 'Meteor' self-pollinated, and (right) 'Crisana' $\times$ 'Meteor'. The pistils were purposely curved before the photographs were taken.

Fig. 2. Length of style of (A) 'Tschernokorka', (B) 'Crisana', (C) 'Meteor', and (D) 'Montmorency' covered by pollen tubes 24, 48, and 72 h after pollination. Values represent the mean of 10 styles per cross. ▨ 24 h, ▩ 48 h, ▧ 72 h after pollination.

removed. Emasculated flowers were hand-pollinated when receptive. 'Schmidt' and 'Emperor Francis' were pollinated 13 May 1989; 'Montmorency', 'Crisana', and 'Tschernokorka' were pollinated 14 May; and

'Meteor' was pollinated 16 May. The minimum and maximum temperatures for 13 through 19 May were 9/15C, 10/20C, 10/21C, 10/25C, 11/29C, 14/27C, and 17/22C, respectively. Ten pollinated pistils per cross

were collected 24, 48, and 72 h after pollination and fixed in Farmer's fixative solution (0.33 glacial acetic acid : 0.67 ethanol).

The pistils were prepared for UV fluorescent microscopy with a modification of Mar-

Table 1. A diallel crossing experiment determining self-incompatible (-) and self-compatible (+) pollinations among six cherry cultivars.

Pistil	Pollen					
	EF	Sch	Tsch	Cris	Met	Mont
Emperor Francis	-	+	+	+	+	+
Schmidt	+	-	+	+	+	+
Tschernokorka	+	+	-	+	+	+
Crisana	+	+	+	-	+	+
Meteor	+	+	+	+	+	+
Montmorency	+	+	+	+	+	+

tin's technique (1959). The pistils were thoroughly washed under running tap water and autoclave for 10 min in 1% sodium sulfite solution to soften the tissues. After removal of the epidermis, the pistils were soaked in 0.1% aniline blue solution at pH 8.5 for 10 to 15 min. Pollen tubes were observed by UV fluorescent light microscopy.

'Tschernokorka' and 'Crisana' sour cherries and the sweet cherry cultivars are self-incompatible; no pollen tubes reaching the ovule. 'Meteor' and 'Montmorency' are self-compatible, with some pollen tubes reaching the ovule (Table 1). Self-incompatibility in 'Tschernokorka' and 'Crisana' was characterized by inhibition of pollen tube growth in the stylar tissue (Fig. 1). Self-pollen of 'Crisana' and 'Tschernokorka' initially grew as fast as foreign sour cherry pollen; however, pollen growth was reduced 48 h after pollination and stopped about half way down the styles 72 h after pollination (Fig. 2 A and B). In the incompatible sour cherry pollinations, pollen tube branching, bursting, or growth reversal were observed. The swelling of pollen tube tips, which is usually associated with gametophytic incompatibility, was observed for the sweet cherry cultivars but not for the self-incompatible sour cherry cultivars.

'Montmorency' and 'Meteor' are self-compatible, with self-pollen successfully reaching the ovule. However, 'for 'Montmorency', self-pollen grew slower than foreign pollen (Fig. 2D). In the 'Meteor' styles, pollen generally grew more slowly than the styles of the other sour cherry cultivars (Fig. 2C). Additionally, for both 'Montmorency'

and 'Meteor', very few self-pollen tubes reached the last one-third of the style (Fig. 1), many of them being inhibited along the transmitting tissue in a pattern more variable than that exhibited for out-cross pollinations (Fig. 1, right). This pattern could not be attributed to pollen quality, since the 'Montmorency' and 'Meteor' pollen grew successfully in the styles of other cultivars. We noted that sweet cherry pollen generally grew faster than sour cherry pollen in sour cherry styles (Fig. 2A-D).

Out of 33 hybrid seedlings tested for self-incompatibility, 11 were self-incompatible, exhibiting stylar inhibition of the pollen similar to that observed in 'Tschernokorka' and 'Crisana'. Seven of these self-incompatible seedlings are from the following crosses, where both parents are self-compatible: 'Rheinische Schattenmorelle' × 'Erdi Botermo', 'English Morello' × 'Meteor', 'English Morello' × M71, and 'English Morello' × 'Hungarian Meteor'. All four seedlings evaluated from the cross 'English Morello' × 'Crisana' were self-incompatible.

Self-incompatibility in sour cherry is characterized by stylar inhibition of pollen tube growth, suggesting gametophytic self-incompatibility, as reported for other self-incompatible *Prunus* species. In the incompatible pollinations, the pollen tubes initially grew normally; however, growth stopped when the pollen tubes were about half way down the style. Our results are contrary to those observations of Lech and Tyhrs (1983) that the sour cherry cultivar Koroser, presumably synonymous to the Romanian cultivar Crisana, exhibited stigmatic inhibition.

Redalen (1984b) classified 'Montmorency' and 'Meteor' as partially self-incompatible, based on low fruit set following self-pollinations. 'Montmorency' and 'Meteor' did exhibit inhibition of a large percentage of self-pollen in the style and, therefore, this observation could represent the partial self-incompatibility described by Redalen (1984a, 1984b).

Since self-incompatible seedlings resulted from crosses between self-compatible cultivars, these parental cultivars may carry self-incompatibility alleles. In sour cherry, these self-incompatibility alleles may be present in a higher frequency than has previously been suspected.

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